Francis Fukuyama, ***Our Posthuman Future: Consequences of the Biotechnology Revolution*****, New York: Ferrar, Straus, and Giroux, 2002.**

In this book, Francis Fukuyama argues that as a result of biomedical advances, we are facing the possibility of a future in which our humanity itself may be altered beyond recognition. Fukuyama making a case for political control of emerging technology argues that the most significant threat posed by contemporary biotechnology is the possibility that it will alter human nature. Biotechnology, in contrast to many other scientific advances, mixes obvious benefits with subtle harms in one package, i.e., in many cases it offers us a devil's bargain: longer life, but with reduced mental capacity.

It would very well happen that advances in stem cell research allow scientists to regenerate virtually any tissue in the body, such that life expectancies are pushed well above 150 years. However, there may not be any remedy for brain damage from diseases such as Alzheimer's. This could mean that we may come to have huge populations of people living vegetative lives It could also happen that wealthy people may get their children optimized by getting their embryos screened before implantation. This could actually create almost a different kind of human sub-species. It is also quite frightening to imagine that human genes have been transferred to animals and even to plants, for research purposes and to produce new medical products; and animal genes have been added to certain embryos to increase their physical endurance or resistance to disease. Scientists have not dared produce a full-scale chimera, half-human and half-ape, though they could.

Events are moving so fast that we need to do something about the direction of future developments so that the technology remains man's servant rather than his master. Since it seems very unlikely that we will either permit everything or ban research that is highly promising, we need to find a middle ground. This middle ground would be provided by liberal democracy. One important reason for the worldwide convergence on liberal democracy had to do with the tenacity of human nature. For while human behaviour is plastic and variable, it is not infinitely so; at a certain point deeply rooted natural instincts and patterns of behaviour reassert themselves to undermine the social engineer's best-laid plans. Many socialist regimes abolished private property, weakened the family, and demanded that people be altruistic to mankind in general rather than to a narrower circle of friends and family. But evolution did not shape human beings in this fashion. Thus, individuals in socialist societies resisted the new institutions at every turn. Liberal democracy has merged as the only viable and legitimate political system for modern societies shaping politics according to historically created norms of justice while not interfering excessively with natural patterns of behaviour.

Modern biotechnology has *already* produced affects that will have consequences for world politics in the coming generation, even if genetic engineering fails to produce a single designer baby before then. Genes contain the code for the proteins that control chemical reactions within the body and are the building blocks of the body's cells. As time goes by, we shall know more and more about the functioning of genes. Joe Tsien, a Princeton biologist, was able to produce mice with superior memory. This may have far reaching consequences for human intelligence. Given the similarities between human and animal genotypes, it will play an important role in genetic engineering. In the future world in which social barriers to mobility were falling and the

rewards to intelligence rising, society would be increasingly stratified along cognitive lines. Genes and not social background would be the key to success. The most intelligent would walk away with most of the earnings; indeed, due to 'assortative mating' (the tendency of people to marry like people) the cognitive elite would tend to increase its relative advantage over time. Those of lower intelligence would face severely limited life chances.

The rise of psychotropic drugs has coincided with what has been called the neurotransmitter revolution- that is, a vast increase in scientific knowledge about the biochemical nature of the brain and its mental processes. The dozen or so neurotransmitters, such as serotonin, dopamine, and norepinephrine, control the firing of nerve synapses and the transmission of signals across the neurons in the brain. The levels of these neurotransmitters and the way they interact directly affect our subjective feelings of well-being, self-esteem, fear, and the like. Their baseline levels are affected by things that go on in the environment and are very much related to what we understand to be personality. Long before genetic engineering becomes a possibility, knowledge of brain chemistry and the ability to manipulate it will become an important source of behaviour control that will have significant political implications. We are already in the midst of this revolution. Take the case of Prozac, for instance. Prozac blocks the reabsorption of serotonin by the nerve synapses and effectively increases the levels of serotonin in the brain. Serotonin is a key neurotransmitter: low levels are associated, in both humans and other primates, with poor impulse control and uncontrolled aggression against inappropriate targets, and in humans, with depression, aggression, and suicide. Books by D. Kramer (*Listening To Prozac*) and Elizabeth Wurtzel (*Prozac Nation: A Memoir*) both celebrate Prozac as wonder drug that effects miraculous changes in personality. Kramer describes a patient of his, Tess, who was chronically depressed, locked into a series of masochistic relationships with married men, and at a dead end at work. Within weeks of taking Prozac, her personality changed completely: she dropped her abusive relationship and started dating other men, changed her circle of friends entirely, and became more confident and less conciliatory in her management style at work. Kramer's book became a best-seller and contributed enormously to the use and acceptance of the drug. Today, Prozac and its relative drugs are taken by 10 percent of the entire population of USA. Because more women than men suffer from depression and low self-esteem, it has also become something of a feminist icon. Self-esteem refers to a critical aspect of human psychology, the desire all people have for recognition. It is the prideful side of the human personality that demands that other people recognize one's worth or dignity It is not a desire for some material good or object to satisfy a need- the motivation- but rather an inter-subjective demand that some other human being acknowledge one's status. Indeed, the economist Robert Frank points out that much of what we understand to be economic interest is really a demand for status recognition, or what he labels positional goods. That is, we want that Jaguar not so much because we love beautiful cars but because we want to trump our neighbor's BMW. The demand for recognition does not have to be personal; one can demand that other people recognize one's gods, or sense of the sacred, or nation, or just cause as well. Most political theorists have recognized the centrality of recognition and the way that it is particularly crucial to politics. A prince fighting another prince does not need the land or money; he usually has more than he knows what to do with. What he wants is recognition of his dominion or sovereignty, the acknowledgment that he is king of kings. The demand for recognition frequently trumps economic interest: new nations like Ukraine and Slovakia might have been better off remaining parts of larger countries, but what they sought was not economic

welfare but their own flag and seat at the United Nations. The desire for recognition has a biological basis and this basis is related to levels of serotonin in the brain. It has been shown that monkeys at the low end of the dominance hierarchy have low levels of serotonin and that, conversely, when a monkey wins alpha male status, he feels a 'serotonin high.' It is for this reason that a drug like Prozac looks so politically consequential. In other words, Prozac can provide self-esteem, so to speak, in a bottle by elevating brain serotonin. The existence of Prozac opens the way for the taking of a drug not for therapeutic value but simply because it makes one feel 'better than good.' If a sense of self-esteem is so crucial to human happiness, who would not want more of it?

If Prozac appears to be some type of happiness pill, Ritalin has come to play the role of an overt instrument of social control. Ritalin is used today to treat a syndrome known as ADHD (Attention Deficit-Hyperactivity Disorder), a 'disease' commonly associated with young boys who have trouble sitting still in class. Young human beings, and particularly young boys, were not designed by evolution to sit around at a desk for hours at a time paying attention to a teacher, but rather to run and play and do other physically active things. The fact that we increasingly demand that they sit still in classrooms, or that parents and teachers have less time to spend with them on interesting tasks, is what creates the impression that there is a growing disease. Ritalin is a central nervous system stimulant which increases attention span, creates a sense of euphoria, builds short-term energy levels, and allows greater focus. Indeed, lab animals given the option of self-administering either Ritalin or cocaine do not show a strong preference for one over the other. These drugs will increase the focus, concentration, and energy levels of normal people as well. If used to excess, Ritalin can have side effects similar to cocaine, including insomnia and weight loss. The beneficial psychological effects of Ritalin explain why it is used, or say abused, by increasing numbers of people who are not diagnosed with ADHD. During the 1990s, Ritalin became one of the fastest-growing drugs used in high schools and on college campuses in the US, as students discovered it helped them study for exams and pay better attention in class. There were cases when mothers stole their children's pills for their own use. The politics of Ritalin is very revealing of the impoverished thought categories by which we have come to understand character and behaviour, and it offers us a foretaste of what will come if and when genetic engineering, with its potentially far more powerful behavioral enhancements, becomes available. Those who believe that they are suffering from ADHD are often desperate to believe that their inability to concentrate or to perform well in some life function is not, as they have often been told, a matter of poor character or weak will but the result of a neurological condition.

Prozac and Ritalin are only the first generation of psychotropic drugs. In the future, virtually everything that the popular imagination envisions genetic engineering accomplishing is much more likely to be accomplished sooner through neuropharmacology. Time is not far off when drugs may be available to help maintain restful but active wakefulness; to produce adequate sleep in a shorter period without the side effects of a sedation; to improve the ability to learn new facts, retain knowledge, and improve factual recall; and to increase stamina and motivation. Finally, it may be possible to manipulate the endogenous opiate system to decrease sensitivity to pain and increase the threshold of pleasure.

We do not have to wait for genetic engineering and designer babies to have a foretaste of the kinds of political forces that will push forward new medical technologies; we can see all of them operating in the realm of neuropharmacology. The spread of psychotropic drugs in the US

demonstrates three powerful political trends that will reappear with genetic engineering. The first is the desire on the part of ordinary people to medicalize as much of their behaviour as possible and thereby reduce their responsibility for their own actions. The second is the pressure of powerful economic interests to assist in this process. These interests include social service, providers such as teachers and doctors, who will always prefer biological shortcuts to complex behavioral interventions, as well as the pharmaceutical companies that produce the drugs.

One important pathway by which contemporary biotechnology will affect politics is through the prolongation of life, and the demographic and social changes that will occur as a result. In the US life expectancy at birth for men and women was respectively 48.3 and 46.3 years in 1900; and in the year 2000, it creased to 74.2 and 79.9 years respectively for men and women. This shift, coupled with dramatically falling birthrates in much of the developed world, has already produced a very different global demographic backdrop for world politics, whose effects are arguably being felt already. Based on birth and mortality patterns already in place, the world will look substantially different in the year 2050 than it does today, even if biomedicine fails to raise life expectancies by a single year over that period of time.

One of the areas most affected by advances in molecular biology has been gerontology (the study of aging). There are at present a number of competing theories as to why people grow old and eventually die, with no firm consensus as to the ultimate reasons or mechanisms by which this occurs. One major theory on aging is related to specific cellular mechanisms by which the body loses its functionality and dies. There are two types of human cells: germ cells, which are contained in the female ovum and male sperm, and somatic cells, which include the other hundred trillion or so cells that constitute the rest of the body. All cells replicate by cell division. In 1961, Leonard Hayflick discovered that somatic cells had an upper limit in the total number of divisions they could undergo. The number of possible cell divisions decreased with the age of the cell. A popular explanation of this is that with the accumulation of random genetic damage as cells replicate. With each cellular division, environmental factors like smoke and radiation, and cellular waste products, can prevent the accurate copying of the DNA from one cell generation to the next. The body has a number of DNA repair enzymes that oversee the copying process and fix transcription problems as they arise, but these fail to catch all mistakes. With continued cell replication, the DNA damage builds up in the cells, leading to faulty protein synthesis and impaired functioning. These impairments are in turn the basis for diseases characteristic of old aging, such as arteriosclerosis, heart disease, and cancer. There is another theory that seeks to explain the Hayflick limit is related to telomeres, the non-coding bits of DNA attached to the end of each chromosome. Telomeres act like the leaders in a filmstrip and ensure that the DNA is accurately replicated. Cell division involves the splitting apart of the two strands of the DNA molecules and their reconstitution into complete new copies of the molecule in the daughter cells. But with each cell division, the telomeres get a bit shorter, until they are unable to protect the ends of the DNA strand and the cell, recognizing the short telomeres as damaged DNA, ceases growth. Dolly the sheep, cloned from somatic cells of an adult animal, had the shortened telomeres of an adult rather than the longer ones of a newborn lamb, and that is why it did not live long as a naturally born sibling. There are three major types of cells that are not subject to the Hayflick limit: germ cells, cancer cells, and certain types of stem cells. The reason these cells can reproduce indefinitely has to do with the presence of an enzyme called telomerase, first isolated in 1989, which prevents the shortening of telomeres. This is what permits the germ line

to continue through the generations without end, and is also what lies behind the explosive growth of cancer tumours.

If a shortcut to immortality exists, the race is already on within the biotech industry to find it. There are active research programs on into embryonic stem cells. Stem cells are cells that make up an embryo at the earliest stages of development, before there has been any differentiation into different types of tissue and organs. Stem cells have the potential to become any cell or tissue in the body, and hence hold the promise of generating entirely new body parts to replace ones worn out through the aging process. Unlike organs transplanted from donors, such cloned body parts will be almost genetically identical to cells in the body into which they are placed, and so presumably free from the kinds of immune reactions that lead to transplant rejections.

It is impossible to know at this point whether the biotech industry will eventually be able to come up with a shortcut to the prolongation of life, such as a simple pill that will add another decade or two to people's life spans. Even if this never happens, however, it seems fairly safe to say that the *cumulative* impact of all the biomedical research going on at present will be to further increase life expectancies over time and therefore to continue the trend that has been under way for the last century. So it is not at all premature to think through some of the political scenarios and social consequences that might emerge from demographic trends that are already well under way.

Increasing life expectancies are only part of the story of what has happened to populations in the developed world by the end of the twentieth century. The other major development has been the dramatic fall in fertility rates. Countries such as Italy, Spain, and Japan have total fertility rates (that is, the average number of children born to a woman in her lifetime) of between 1.1 and 1.5, far below the replacement rate of about 2.2. The combination of falling birthrates and increasing life expectancies has dramatically shifted the age distribution in developed countries. The looming crisis is real enough for countries like Japan where a generation or two from now there shall be one retired person for every two workers. Compared to this situation, many of the poorer countries continue to experience high rates of population growth. This means that the dividing line between the First and the Third Worlds in two generations will be a matter not simply of income and culture but of age as well, with Europe, Japan, and parts of North America having a median age as much as 2.5 to 3 times higher than their less developed neighbours. In addition, voting age populations in the developed world will be more heavily feminized, in part because more women in the growing elderly cohort will live to advanced ages than men, and in part because of a long-term sociological shift toward greater female political participation. Indeed, elderly women will emerge as one of the most important blocs of voters courted by twenty-first-century politicians. Developed countries shall also face serious problems in their defense policies too. Elderly people, and particularly elderly women, are not the first to be called to serve in military organizations, so the pool of available military manpower will shrink. The willingness of people in such societies to tolerate battle casualties among their young may fall as well. It has been estimated that given current fertility trends, countries like Italy in 2050 will be a society in which only 5 percent of all children have any collateral relatives (that is, brothers, sisters, aunts, uncles, cousins, and so forth) at all. People will be primarily related to their parents, grandparents, great-grandparents, and to their own offspring. Such a tenuous generational line is likely to increase the reluctance to go to war and accept death in battle. The world may well be divided, then, between a North whose political tone is set by elderly women, and a South driven

by what Thomas Friedman labels super-empowered angry young men. It was a group of such men that carried the 9/11 attacks on the World Trade Center. This does not, of course, mean that the North will fail to rise to the challenges posed by the South, or that conflict between the two regions is inevitable. Biology is not destiny. But politicians will have to work within frameworks established by basic demographic facts, and one of those facts may be that many countries in the North will be both shrinking and aging. There is another, perhaps more likely, scenario that will bring these worlds into direct contact: immigration. The developed countries will want economic growth and the population necessary to sustain it. This means that the North-South divide will be replicated within each country, with an increasingly elderly native-born population living alongside a culturally different and substantially younger immigrant population. Though some countries like Canada have traditionally been good at assimilating culturally diverse groups of immigrants, but other countries like Germany and Japan, have not. Many countries like Germany, Italy, Austria, and France have already seen the rise of anti-immigrant backlash movements. For these countries, changes in the age structure of their populations, abetted by increasing longevity, are likely to lay the ground for growing social conflict. Life extension will also wreck havoc with most existing age-graded hierarchies. With people routinely working into their 80s, 90s and even beyond shall create a scenario where the natural tendency of one generation to get out of the way of the up-and-coming one will be replaced by the simultaneous existence of three, four, even five generations. Deleterious consequences can already be seen of prolonged generational succession in authoritarian regimes that have no constitutional requirements limiting tenure to office. As long as dictators like Mao Zedong, Kim Il Sung, and Francisco Franco physically survive, their societies have no way of replacing them, and all political and social change is effectively on hold until they die. In the future, with technologically enhanced life spans, such societies may find themselves locked in ludicrous deathwatch not for years but for decades. The root problem, of course, lies in the fact that people at the top of social hierarchies generally do not want to lose status or power and will often use their considerable influence to protect their positions. Age-related declines in capabilities have to be fairly pronounced before other people would go to the trouble of removing a leader, boss, professor, or board member. Impersonal formal rules like mandatory retirement ages are useful precisely because they do not require institutions to make nuanced personal judgements about an individual older person's capability. But impersonal rules often discriminate against older people who are perfectly capable of continuing to work and for that reason have been abolished in many American workplaces. It stands to reason that political, social, and intellectual change will occur much more slowly in societies with substantially longer average life spans. With three or more generations active and working at the same time, the younger age cohorts will never constitute more than a small minority of voices clamouring to be heard, and generational changes will never be fully decisive. Older people will have to move down the social hierarchy not just to retain but to make room for new entrants coming up from the bottom. Other social effect of life extension will depend on the exact way that the geriatric revolution plays itself out- that is, whether people will remain physically and mentally vigorous throughout these lengthening life spans, or whether society will increasingly come to resemble a giant nursing home. Ideally, one would like not merely to live longer but also to have one's different faculties fail as close as possible to when death finally comes, so that one does not have to pass through a period of debility at the end of life. While many medical advances have increased the quality of life for older people, many have had the opposite effect by prolonging

only one aspect of life and increasing dependency. Alzheimer's disease- in which certain parts of the brain waste away, leading to loss of memory and eventually dementia- is a good example of this. At age 65, only one person in a hundred is likely to come down with Alzheimer's; at 85, it is one in six. The rapid growth in the population suffering from Alzheimer's in developed countries is thus a direct result of increased life expectancies, which have prolonged the health of the body without prolonging resistance to this terrible neurological disease. There are in fact two periods of old age that medical technology has opened up, at least for people in the developed world. In the first category which extends from age 65 until sometime in one's 80s, when people can increasingly expect to live healthy and active lives, with enough resources to take advantage of them. The second period that most people currently reach by their 80s, when their capabilities decline and then they return increasingly to a childlike state of dependency. This is the period that society does not like to think about, much less experience, since it flies in the face of ideals of personal autonomy that most people hold dear. Increases in both these categories have created a novel situation in which individuals approaching retirement age today find their own choices constrained by the fact that they still have an elderly parent alive and dependent on them for care. The best scenario would be one in which technology simultaneously pushes back parallel aging process- for instance, by the discovery of a common molecular source of aging in all somatic cells, and the delaying of this process throughout the body. Failure of the different parts would come at the same time, just later. People in first category would be more numerous and those in second category less so. The worst scenario would be one of highly uneven advance, in which, for instance, we found way to preserve bodily health but could not put off age-related mental deterioration. Stem cell research might yield ways to grow new body parts, but without a parallel cure for Alzheimer's disease, this wonderful new technology would do no more than allow more people to persist in vegetative states for years longer than is currently possible. An explosion in the number of people in second category might be labeled the national nursing home scenario, in which people routinely live to be 150 but spend the last fifty years in a state of childlike dependence on caretakers. If there is no molecular shortcut to postponing death because aging is the result of the gradual accumulation of damage to a wide variety of different biological systems, then there is no reason to think that future medical advances will proceed with a neat simultaneity, any more than they have in the past. That existing medical technology is capable only of keeping people's bodies alive at a much reduced quality of life is the reason of assisted suicide and euthanasia. The biggest fear is that people in the second category may find their lives emptier and lonelier.

Today, genetic engineering is used commonly in agricultural biotechnology to produce genetically modified organisms such as Bt corn (which produces its own insecticide), products that have been the focus of controversy and protest around the world. The next line of advance is obviously to apply this technology to human beings. Human genetic engineering raises most directly the prospect of a new kind of eugenics, with all the moral implications with which that word is fraught, and ultimately the ability to change human nature. The merger of biology and information technology has led to the emergence of a new field, known as bioinformatics. What will be possible in the future will depend heavily on the ability of computers to interpret mind-boggling amounts of data generated by genomics and proteomics and to build reliable models of phenomena such as protein folding.

Genes are some kind of parallel-processing chemical computers in which genes are

continuously turning one another on and off in some vastly complex network of interaction. Cell-signaling pathways are linked to genetic regulatory pathways in ways we're just beginning to unscramble.

The first step toward giving parents greater control over the genetic makeup of their children will come not from genetic engineering but with preimplantation genetic diagnosis and screening. In the future it should be routinely possible for parents to have their embryos automatically screened for a wide variety of disorders, and those with the 'right' genes implanted in the mother's womb. Present-day medical technology, such as aminocentesis and sonograms, gives parents a certain degree of choice already, as when a fetus diagnosed with Down's syndrome is aborted, or when girl fetuses are aborted in Asia. Embryos have already been successfully screened for birth defects like cystic fibrosis. Geneticist Lee Silver paints a future scenario in which a woman produces a hundred or so embryos, has them automatically analyzed for a 'genetic profile,' and then with a few clicks of the mouse selects the one that not only lacks alleles for single-gene disorders like cystic fibrosis, but also has enhanced characteristics, such as height, hair colour, and intelligence. The technologies to bring this about do not exist now but are on the way. A company called Affymetrics has already developed a so-called DNA chip that automatically screens a DNA sample for various markers of cancer and other disorders. There are already efforts being made certain sects like the Raelians who are attempting to clone a human being. The ultimate prize of modern genetic technology will be the 'designer baby.' That is, geneticists will identify the 'gene for' a characteristic like intelligence, height, hair colour, aggression, or self-esteem and use this knowledge to create a 'better' version of the child. The gene in question may not have to come from a human being. This is, after all, what happened in agricultural biotechnology. Bt corn has an exotic gene inserted into its DNA that allows it to produce a protein that works as a poison for insect pests. The resulting plant is thus genetically modified to produce its own pesticide, and it hands down this characteristic to its offspring.

There are two ways by which genetic engineering can be accomplished: somatic gene therapy and germ-line engineering. The first attempts to change the DNA within a large number of target cells, usually by delivering the new, modified genetic material by means of a virus or 'vector'. The problem with this approach is that the body is made up of trillions of cells; for the therapy to be effective, the genetic material of what amounts to millions of cells has to be altered. The somatic cells in question die with the individual being treated, if not before; the therapy has no lingering generational effects. Germ-line engineering, by contrast, is what is done routinely in agricultural biotechnology and has been successfully carried out in a wide variety of animals. Modification of the germ line requires, at least in theory, changing only one set of DNA molecules, those in the fertilized egg, which will eventually undergo division and ramify into a complete human being. While somatic gene therapy changes only the DNA of somatic cells, and therefore affects only the individual who receives the treatment, germ-line changes are passed down to the individual's offspring. This has obvious attractions for the treatment of inherited diseases, such as diabetes. Among other new technologies currently under study are artificial chromosomes that would add an extra chromosome to the forty-six natural ones; the chromosome could be turned on only when the recipient was old enough to give his/her informed consent and would not be inherited by the descendants. This technique would avoid the need to alter or replace genes in existing chromosomes. Artificial chromosomes might thus constitute a bridge between preimplantation screening and permanent modification of the germ line.

Before human beings can be genetically modified in this manner, however, a number of steep obstacles need to be overcome. Genes have been compared to ecosystem, where each part influences every other part, in heredity as in the environment, you cannot do just one thing. When a gene is changed by mutation or replaced by another gene, unexpected and possibly unpleasant side effects are likely to follow. Thus, one would presumably not want to create a human baby until one had a much higher chance of success, and even than the cloning process might produce defects that would not show up for years. Designer babies will be expensive at first and an option only for the well-to-do.

Highly skewed sex ratio can produce important social consequences. As suggested by Charles Murray, by the second decade of the twenty-first century, China will face a situation in which up to one fifth of its marriage-age male population will not be able to find brides. It is hard to imagine a better formula for trouble, given the propensity of unattached young males to be involved in activities like risk-taking, rebellion, and crime. On the positive side: the deficit of women will allow females to control the mating process more effectively, leading to more stable family life for those who can get married.

Even if genetic engineering never materializes, greater knowledge about genetic causation, neuropharmacology, and the prolongation of life, will have important consequences. Or even if genetic engineering on a species level remains a few generations away, it is by far the most consequential of all future developments in biotechnology. The reason for this is that human nature is fundamental to our notions of justice, morality, and the good life, and all of these will undergo change if this technology becomes widespread.

Many of the characteristics that a parent might want to give a child have to do with the subtler elements of personality whose benefits are not as clear-cut as looks or intelligence. Parents may be under the sway of a contemporary fad or cultural bias or simple political correctness: one generation may prefer ultrathin girls, or pliable boys, or children with red hair- preferences that can easily fall out of favour in the next generation. One could argue that parents are already free to make such mistakes on behalf of their children and do so all the time by miseducating them or imposing their own quirky values on them. But a child who is brought up in a certain way by a parent can rebel later. Genetic modification is more like giving your child a tattoo that she can never subsequently remove and will have to hand down not just to her own children but to all subsequent descendants. Cultural norms may also lead parents to make choices that harm their children. For instance, the use in Asia of sonograms and abortion to select the sex of offspring.

Care for elderly parents has already begun to displace child care as a major preoccupation for people alive today. In the future, they may feel enslaved to the two, three, or more generations of ancestors dependent upon them. Another important type of negative externality is related to the competitive, zero-sum nature of many advantages on individuals who are above average, in terms of sexual attractiveness, social status, athletic opportunities, and the like. But these advantages are only relative: if many parents seek to have children tall enough to, say play in the American NBA, it will lead to an arms race and no net advantage to those who participate in it. This will even be true of a characteristic like intelligence, which is often cited as one of the first and most obvious targets of future genetic enhancement. A society with higher average intelligence may be wealthier, insofar as productivity correlates with intelligence. But the gains many parents seek for their children may prove illusory in other respects, because the advantages of higher intelligence are relative and not absolute. People want smarter kids so that they will get into Harvard, for

instance, but competition for places at Harvard is zero-sum: if my kid becomes smarter because of gene therapy and gets in, he/she simply replaces your kid. My decision to have a designed baby imposes a cost on you (or rather, on your child), and in the aggregate it is not clear that anyone is better off. This kind of genetic arms race will impose special burdens on people who for religious or other reasons do not want their children genetically altered; if anyone around them is doing it, it will be much harder to abstain, for fear of holding their own children back.

However, hidden dangers can never be overlooked. This has proven true with regard to the environment: ecosystems are interconnected wholes whose complexity we frequently do not understand; building a dam or introducing a plant monoculture into an area disrupts unseen relationships and destroys the system's balance in totally unanticipated ways. So too with human nature. There are many aspects of human nature that we think we understand all too well or would want to change if we had the opportunity. But doing nature one better is not always that easy; evolution may be blind process, but it follows a ruthless adaptive logic than makes organisms fit for their environments.

Understanding the good and bad in human nature is far more complex than one would think, because they are so intertwined. In evolutionary history, human beings learned to cooperate in order to compete and an elaborate degree of social organization was created not by the struggle against natural environment but rather by the fact that human groups had to struggle against one another. This led over evolutionary time to an arms-race situation, in which increasing social cooperation on the part of one group forced other groups to cooperate in similar ways in a never-ending struggle. Human competitiveness and cooperativeness remain balanced in a symbiotic relationship not just over evolutionary time, but in actual human societies and in individuals. We certainly hope that human beings will learn to live peacefully in many circumstances where they do not do so today, but if the balance shifts too far away from aggressive and violent behaviour, the selective pressures in favour of cooperation will also weaken. Societies that face no competition or aggression stagnate and fail to innovate; individuals who are too trusting and cooperative make themselves vulnerable to others who are more bloody-minded. So too with the family. Since Plato's time, it has been widely understood among philosophers that the family stands as the major obstacle to the achievement of social justice. People, as kin selection theory suggests, tend to love their families and relatives out of proportion to their objective worth. While there is a conflict between fulfilling an obligation to a family member and fulfilling an obligation to an impersonal public authority, family comes first. This is why Socrates argues in Book V of *The Republic* that a perfectly just city requires the communism of women and children, so that parents will not know who their biological offspring are and therefore will not be in a position to favour them. This is also why all modern rule-of-law societies must enforce myriad regulations forbidding nepotism and favouritism in public service. And yet the natural propensity to love one's own offspring to the point of irrationality has a powerful adaptive logic: if a mother does not love her children in this way, who else will devote the resources, both material and emotional, that are required to raise a child into mature adulthood? Other institutional arrangements, like communes and welfare agencies, work a good deal less well because they are not based on natural emotions. There is, moreover, a profound justice to the natural process, for it guarantees that even children who are unlovely or untalented will have a parent to love them in spite of their disadvantages. Precisely because of the irrationality of family life, all real-world communist regimes targeted the family as a potential enemy of the state. Soviet Union celebrated a little

monster named Pavel Morozov, who turned in his parents to Stalin's police in the 1930s, precisely to try to break the hold the family naturally has on people's loyalties. Maoist China engaged in a prolonged struggle against Confucianism, with its emphasis on filial piety, and turned children against parents during the Cultural Revolution in the 1960s. We should be skeptical of libertarian arguments that say that as long as eugenic choices are being made by individuals rather than by state, we need not worry about possible bad consequences. Free markets work well much of the time, but there are also market failures that require government intervention to correct. Negative externalities do not simply take care of themselves. We do not know at this point whether these externalities will be large or small, but we should not assume them away out of a rigid commitment to markets and individual choice.

The biggest fear about biotechnology is that it could cause us in some way to lose our humanity- that is, some essential quality that has always underpinned our sense of who we are and where we are going, despite all of the evident changes that have taken place in the human condition through the course of history. Worse yet, we might make this change without recognizing that we had lost something of great value. We might thus emerge on the other side of a great divide between human and posthuman history and not even see that the watershed had been breached because we lost sight of what that essence was. It would have to do with human nature: the species-typical characteristics shared by all human beings as 'human beings'. That is ultimately what is at stake in the biotech revolution. Human nature is what gives us a moral sense, provides us with the social skills to live in society, and serves as a ground for more sophisticated philosophical discussions of rights, justice, and morality.

Genetic engineering could actually be used to create a class of genetically superior people. There could be a situation in which we could end up having a class called the GenRich steadily improve the cognitive abilities of their children to the point that they break off from the rest of the human race to form a separate species. The most clear and present danger is that the large genetic variations between individuals will narrow and become clustered within certain distinct social groups. Today, the 'genetic lottery' guarantees that the son or daughter of a rich and successful parent will not necessarily inherit the talents and abilities that created conditions conducive to the parent's success. Of course, there has always been a degree of genetic selection: assortative mating means that successful people will tend to marry each other and, to the extent that their success is genetically based, will pass on to their children better life opportunities. But in the future, the full weight of modern technology can be put in the service of optimizing the kinds of genes that are passed on to one's offspring. This means that social elites may not just pass on social advantages but embed them genetically as well. This may one day include not only characteristics like intelligence and beauty, but behavioral traits like diligence, competitiveness, and the like. There cold be two solutions for this problem. The first and the most sensible would simply be to forbid the use of biotechnology to enhance human characteristics and decline to compete in this dimension. But the notion of enhancement may become too powerfully attractive to forgo, or it may prove difficult to enforce a rule preventing people from enhancing their children, or the courts may declare they have a right to do so. At this point a second possibility opens up, which is to use that same technology to raise up the bottom.